The Handbook of Nanomedicine

Second Edition

The Handbook of Nanomedicine

Second Edition

Kewal K. Jain MD, FRACS, FFPM

Jain PharmaBiotech, Basel, Switzerland

Humana Press

Kewal K. Jain
Jain PharmaBiotech
Blaesiring 7
Basel 4057
Switzerland

ISBN 978-1-61779-982-2 ISBN 978-1-61779-983-9 (eBook)
DOI 10.1007/978-1-61779-983-9
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2012940572

Printed on acid-free paper

Humana Press is a brand of Springer
Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

The *Handbook of Nanomedicine* provides a thorough guide to this new and very important interdisciplinary area of science and technology. It provides both the basics and a classification system for nanomedicine. Important areas such as nanoarrays, nanofluidics, nanoparticles, nanogenomics, nanoproteomics, nanobiotechnology, nanomolecular diagnostics, and nanopharmaceuticals are evaluated. The role of biotechnology in biological therapies, and in particular oncology, is discussed. Nanodevices in surgery and medicine are also examined. Another important focus of the handbook is the role of nanomedicine in medical specialty areas—particularly in neurology, cardiology, dermatology, pulmonology, geriatrics, orthopedics, and ophthalmology. Nanomedicine in microbiology and in regenerative medicine and tissue engineering is also discussed. In addition, ethical, safety, regulatory, educational, and commercialization issues are discussed. Finally, the handbook concludes with an assessment of the future of nanomedicine, which is very bright.

Robert Langer Ph.D.
David H. Koch Institute Professor
Massachusetts Institute of Technology
Cambridge, MA, USA

Preface to the Second Edition

Considerable advances have taken place in nanomedicine since the first edition of the book in 2008. The basic plan of the book has been retained with some reorganization, but most of the material has been updated or replaced with new developments. Important classical references were left in while new ones have been added. Most of the advances have occurred in nanodiagnostics and nanopharmaceuticals, particularly drug delivery using nanobiotechnology. Nanooncology remains the major area of clinical application although considerable advances have been made in other therapeutic areas, particularly nanocardiology and nanoneurology. Several new products have been approved, and clinical applications of nanobiotechnology are progressing. This has required the discussion of some regulatory issues. Combination of diagnosis and therapy is facilitated by nanobiotechnology and fits in with concepts of personalized medicine, which is being increasingly accepted. As with the first edition, requirements of both physicians and scientists have been kept in mind. However, the description is kept simple enough to be understood by any educated layperson.

The author wishes to acknowledge the help and encouragement received from Patrick J. Marton, Senior Editor, Springer Protocols, Humana Press, in completion of the project. David Casey has done an excellent job of editing and organizing this book.

Basel, Switzerland — Kewal K. Jain, MD, FRACS, FFPM.

Preface to the First Edition

Nanomedicine is application of nanobiotechnology to clinical medicine. However, new technologies do not always enter medical practice directly. Nanobiotechnologies are being used to research the pathomechanism of disease, refine molecular diagnostics, and help in the discovery, development, and delivery of drugs. In some cases, nanoparticles are the nanomedicines. The role is not confined to drugs before devices, and surgical procedures are refined by nanobiotechnology, referred to as nanosurgery.

This handbook covers the broad scope of nanomedicine. Starting with the basics, the subject is developed to potential clinical applications, many of which are still at an experimental stage. The prefix nano is used liberally and indicates the nanodimension of existing scientific disciplines and medical specialties. Two important components of nanomedicine are nanodiagnostics and nanopharmaceuticals and constitute the largest chapters.

Keeping in mind that the readers of the book will include nonmedical scientists, pharmaceutical personnel, as well as physicians, technology descriptions and medical terminology are kept as simple as possible. As a single author book, duplication is avoided. I hope that readers at all levels will find it a concise, comprehensive, and useful source of information.

There is voluminous literature relevant to nanomedicine. Selected references are quoted in the text.

Basel, Switzerland — Kewal K. Jain, MD, FRACS, FFPM.

Contents

List of Figures

List of Tables

Abbreviations

AFM	Atomic force microscopy
BBB	Blood–brain barrier
BioMEMS	Biological Microelectromechanical Systems
CNS	Central nervous system
DNA	Deoxyribonucleic acid
DPN	Dip Pen Nanolithography
ELISA	Enzyme-linked immunosorbent assay
FDA	Food and Drug Administration (USA)
FRET	Fluorescence resonance energy transfer
LNS	Lipid nanosphere
MEMS	Microelectromechanical Systems
MNP	Magnetic nanoparticle
MRI	Magnetic resonance imaging
NCI	National Cancer Institute (USA)
NIH	National Institutes of Health (USA)
NIR	Near-infrared
NP	Nanoparticle
ODN	Oligodeoxynucleotide
PAMAM	Polyamidoamine (dendrimers)
PCR	Polymerase chain reaction
PEG	Polyethylene glycol

PEI	Polyethylenimine
PLA	Polylactides
PLGA	Poly(lactic-co-glycolic) acid
POC	Point-of-care
QD	Quantum dot
RLS	Resonance light scattering
RNA	Ribonucleic acid
SERS	Surface-enhanced Raman scattering
SNP	Single-nucleotide polymorphism
SPM	Scanning probe microscope
SPR	Surface plasmon resonance